

**Sample Question Paper**  
**CLASS: XII**  
**Session: 2022-23**  
**Applied Mathematics (Code-241)**

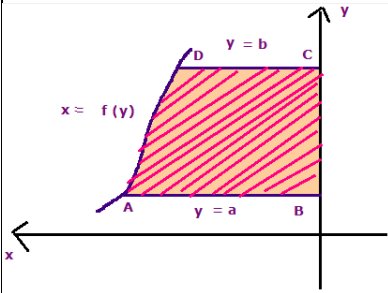
**Time Allowed: 3 hrs**

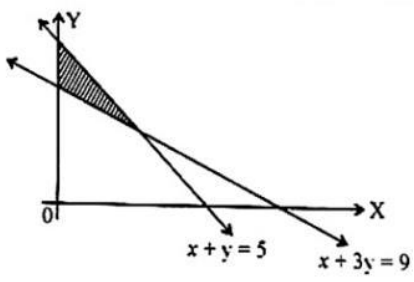
**Maximum Marks: 80**

**General Instructions:**

1. This question paper contains five sections A, B, C, D and E. Each section is compulsory.
2. Section - A carries 20 marks weightage, Section - B carries 10 marks weightage, Section - C carries 18 marks weightage, Section - D carries 20 marks weightage and Section - E carries 3 case-based with total weightage of 12 marks.
- Section – A:**
3. It comprises of **20 MCQs of 1 mark** each.
- Section – B:**
4. It comprises of **5 VSA type questions of 2 marks** each.
- Section – C:**
5. It comprises of **6 SA type of questions of 3 marks** each.
- Section – D:**
6. It comprises of **4 LA type of questions of 5 marks** each.
- Section – E:**
7. It has **3 case studies**. Each case study comprises of 3 case-based questions, where **2 VSA type questions are of 1 mark** each and **1 SA type question is of 2 marks**. Internal choice is provided in **2 marks** question in each case-study.
8. Internal choice is provided in **2 questions in Section - B, 2 questions in Section – C, 2 questions in Section - D**. You have to attempt only one of the alternatives in all such questions.

| <b><u>SECTION – A</u></b>  |  | <b><u>marks</u></b> |
|--|--|---------------------|
| (All questions are compulsory. No internal choice is provided in this section) |  |                     |
| 1.   | What is the least value of 'x' that satisfies $x \equiv 27 \pmod{4}$ , when $27 < x \leq 36$ ?<br><br>a) 27                                      b) 30                                      c) 31                                      d) 35   | 1                   |
| 2.   | Let $p > 0$ and $q < 0$ and $p, q \in Z$ , then choose the correct inequality from the given below options to complete the statement:<br>$p + q \quad \square \quad p - q$ a) $>$ b) $\leq$ c) $\geq$ d) $<$   | 1                   |
| 3.   | A machine makes car wheels and in a random sample of 26 wheels, the test statistic is found to be 3.07. As per the t-distribution test (of 5% level of significance), what can you say about the quality of wheels produced by the machine? (Use $t_{25}(0.05) = 2.06$ )<br><br>a) Superior quality      b) Inferior quality      c) Same quality      d) Cannot say | 1                   |

|     |   |   |
|-----|---|---|
| 4.  | <p>For the purpose of t-test of significance, a random sample of size (<math>n</math>) 34 is drawn from a normal population, then the degree of freedom (<math>\nu</math>) is -</p> <p>a) <math>\frac{1}{34}</math>                      b) 33                      c) 34                      d) 35</p>  | 1 |
| 5.  | <p>A person can row a boat along the stream of the river at 10 km/h and against the stream in 6 km/h. What is the speed of the stream flow?</p> <p>a) 1 km/h                      b) 2 km/h                      c) 4 km/h                      d) 5 km/h</p>   | 1 |
| 6.  | <p>Standard deviation of a sample from a population is called a -</p> <p>a) Standard error                      b) Parameter                      c) Statistic                      d) Central limit</p>  | 1 |
| 7.  | <p>Two water supplying trucks – A and B supply water to remote areas. Truck A is carrying 100 litres of water to a village 1.5 km away and truck B is delivering 80 litres of water to another village, 1 km away. Due to bad road conditions, each truck loses 20 ml water while travelling each metre distance. Which truck is able to deliver more water and by how much more?</p> <p>a) Truck A, 20 litres                      b) Truck B, 20 litres                      c) Truck A, 10 litres                      d) Truck B, 10 litres</p> | 1 |
| 8.  | <p>What is the face value of a sinking fund that yields a dividend of ₹1800 at 10% semi-annually?</p> <p>a) ₹ 3600                      b) ₹18000                      c) ₹ 24000                      d) ₹ 36000</p>   | 1 |
| 9.  | <p>In the given figure, the area bounded by the curve <math>x = f(y)</math>, <math>y</math>-axis and abscissa <math>y = a</math> and <math>y = b</math> is equal to -</p> <p>a) <math>\int_a^b f(y)dy</math>                      b) <math>\int_a^b f(x)dx</math>                      c) <math>\int_a^b  f(y)  dy</math>                      d) <math>\int_a^b  f(x)  dx</math></p>    | 1 |
| 10. | <p>A factory production is delayed for three weeks due to breakdown of a machine and unavailability of spare parts. Under which trend oscillation does this situation fall under?</p> <p>a) Seasonal                      b) Cyclical                      c) Secular                      d) Irregular</p>   | 1 |
| 11. | <p>A newspaper printing machine costs ₹ 4,80,000 and estimated scrap value of ₹ 25,000 at the end of its useful life of 10 years. What is its annual depreciation as per linear method?</p> <p>a) ₹ 4,550                      b) ₹ 45,500                      c) ₹ 50,500                      d) ₹ 61,500</p>  | 1 |

|   |  |   |   |
|---|--|---|---|
| 12.   | <p>In the given figure (I), what is the LPP shaded region known as?</p>  |  <p style="text-align: center;">Figure (I)</p> | 1 |
| <p>a) Feasible region      b) Feasible solution      c) Optimal region      d) Objective region</p>   |  |   |   |
| 13.   | <p>General solution of differential equation: <math>y \log y \, dx - x \, dy = 0</math> is –</p>   |   | 1 |
| <p>a) <math>y = \log  Cx </math>      b) <math>y = e^{ Cx }</math>      c) <math>y = e^{-Cx}</math>      d) <math>\log y =  C + x </math></p>   |  |   |   |
| 14.   | <p>An investment of ₹ 10,000 becomes ₹ 60,000 in 4 years, then the CAGR (compound annual growth rate) is given by –</p>  |   | 1 |
| <p>a) <math>\frac{\sqrt[4]{6}-1}{100}</math>      b) <math>\frac{\sqrt[4]{6}+1}{100}</math>      c) <math>[\sqrt[4]{6} - 1] \times 100</math>      d) <math>[\sqrt[4]{6} + 1] \times 100</math></p> |  |   |   |
| 15.   | <p>In what ratio shall I add water to the liquid detergent costing ₹ 480 per litre to get resulting mixture worth ₹ 300 per litre?</p>   |   | 1 |
| <p>a) 5:3      b) 3:8      c) 3:5      d) 5:8</p>   |  |   |   |
| 16.   | <p>A grain whole-seller visits the granary market. While going around to make a good purchase, he takes a handful of rice from random sacks of rice, in order to inspect the quality of farmers produce. The handful of rice taken from a sack of rice for quality inspection is a:</p>  |   | 1 |
| <p>a) statistic      b) population      c) parameter      d) sample</p>   |  |   |   |
| 17.   | <p>For predicting the straight-line trend in the sales of scooters (in thousands) on the basis of 6 consecutive years data, the company makes use of 4-year moving averages method. If the sales of scooters for respective years are <math>a, b, c, d, e</math> and <math>f</math> respectively, then which of the following average will <u>not</u> be computed?</p> |   | 1 |
| <p>a) <math>\frac{a+b+c+d}{4}</math>      b) <math>\frac{b+c+d+e}{4}</math>      c) <math>\frac{a+c+d+e}{4}</math>      d) <math>\frac{c+d+e+f}{4}</math></p>                                       |  |   |   |
| 18.   | <p>In a school, a random sample of 145 students is taken to check whether a student's average calory intake is 1500 or not. The collected data of average calories intake of sample students is presented in a frequency distribution, which is called a:</p>  |   | 1 |
| <p>a) Statistics      b) Sampling distribution      c) Parameter      d) Population sampling</p>  |  |   |   |

|  |   |   |
|--|---|---|
|  | <p>For questions 19 and 20, two statements are given – one labelled Assertion(A) and the other labelled Reason (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below:</p> <p>(i) Both A and R are true and R is the correct explanation of the assertion<br/> (ii) Both A and R are true but R is not the correct explanation of the assertion<br/> (iii) A is true, but R is false<br/> (iv) A is false, but R is true</p> <p style="text-align: center;">1</p>  |   |
| 19.  | <p><u>Assertion (A)</u> : Kuhu and Beena are two equally capable badminton players. Probability that Beena will beat Kuhu in 3 games out of 4 is 25%</p> <p><u>Reason (R)</u> : The probability of <math>r</math> successes in <math>n</math> trials, denoted by <math>P(X = r)</math> is given by <math>P(X = r) = {}^n C_r p^r q^{n-r}</math>, <math>r = 0, 1, \dots, n</math> where <math>p</math> denotes success and <math>q</math> denotes failure in each trial.</p> <p>a) (i)                                      b) (ii)                                      c) (iii)                                      d) (iv)</p> | 1 |
| 20.  | <p><u>Assertion (A)</u> : If the nominal rate of interest is 12.5% and the inflation is 2%, then the effective rate of interest is 10.5%</p> <p><u>Reason (R)</u> : If the interest is calculated only at the end of an year, then the effective rate of interest is same as the nominal rate of interest.</p> <p>a) (i)                                      b) (ii)                                      c) (iii)                                      d) (iv)</p>  | 1 |
| <p><b>SECTION – B</b></p> <p>(All questions are compulsory. In case of internal choice, attempt any one question only)</p> |   |   |
| 21.  | <p>₹ 2,50,000 cash is equivalent to a perpetuity of ₹ 7,500 payable at the end of each quarter. What is the rate of interest convertible quarterly?</p>   | 2 |
| 22.  | <p>Find value of <math>2a + 3b - c</math>, if <math>A = \begin{bmatrix} 0 &amp; -1 &amp; 28 \\ a - 8 &amp; 0 &amp; 3b \\ -c + 2 &amp; 2 &amp; 0 \end{bmatrix}</math> is a skew-symmetric matrix</p> <p style="text-align: center;"><b>OR</b></p> <p>There are two real value(s) of <math>x</math>, for which the value of the determinant <math>\Delta = \begin{vmatrix} 1 &amp; -2 &amp; 5 \\ 2 &amp; x &amp; -1 \\ 0 &amp; 4 &amp; 2x \end{vmatrix}</math> is 86.</p> <p>Find the value(s) of <math>x</math></p>  | 2 |
| 23.  | <p>A book publisher sells a hard cover edition of a book for ₹ 72 and a paperback edition for ₹ 40. In addition to a fixed weekly cost of ₹ 9,600, the cost of printing hardcover and paperback editions are ₹ 56 and ₹ 28 per book respectively. Each edition requires 5 minutes on the printing machine whereas hardcover binding takes 10 minutes and paperback takes 2 minutes on the binding machine. The printing machine and the binding machine are available for 80 hours each week. Formulate the linear programming problem to maximise the publisher's profit.</p>  | 2 |
| 24.  | <p>A boatman takes half as much time in rowing his boat for a certain distance downstream than upstream. What is the ratio between his speed of rowing the boat in still water and speed of current?</p>  | 2 |

**OR**

In a 200-metre race, Anuj can beat Param by 5 metre or 3 seconds. How much time did Anuj take to complete the race?

25. Mitul invested ₹ 3,50,000 in a fund. At the end of the year the value of the fund is ₹ 4,37,500. What is the nominal rate of interest, if the market price is same at the end of the year?

2

**SECTION – C**

(All questions are compulsory. In case of internal choice, attempt any one question only)

26. Find the interval(s) in which the function  $f(x) = \frac{x^4}{4} - 2x^3 + \frac{11x^2}{2} - 6x$ , is strictly increasing and strictly decreasing.

3

27. Two badminton teams A and B are staying in the same hotel. Team A has 2 male and 3 female players accompanied by 1 coach. Team B comprises of 1 male, 2 female players and 2 coaches. The daily diet requirement (calories and protein) for each person is as given below:

|               | Calories | Protein |
|---------------|----------|---------|
| Male player   | 2500     | 65 g    |
| Female player | 1900     | 50 g    |
| Coach         | 2000     | 54 g    |

3

Use matrix algebra to calculate the total diet requirement of calories and protein for each team.

28. Evaluate  $\int \frac{dx}{(1+e^x)(1+e^{-x})}$

**OR**

Evaluate  $\int x \log(1 + x^2) dx$

3

29. Under the pure market competition scenario, the demand function  $p_d$  and the supply function  $p_s$  for a certain commodity are given as  $p_d = \frac{8}{x+1} - 2$  and  $p_s = \frac{x+3}{2}$  respectively, where  $p$  is the price and  $x$  is the quantity of the commodity. Using integrals, find the producer's surplus.

**OR**

The demand function  $p$  for maximising a profit monopolist is given by  $p = 274 - x^2$  while the marginal cost is  $4 + 3x$ , for  $x$  units of the commodity. Using integrals, find the consumer surplus

3

30. Surjeet purchased a new house, costing ₹ 40,00,000 and made a certain amount of down payment so that he can pay the balance by taking a home loan from XYZ Bank. If his equated monthly instalment is ₹ 30,000, at 9% interest compounded monthly (reducing balance method) and payable for 25 years, then what is the initial down payment made by him?  
[Use  $(1.0075)^{-300} = 0.1062$ ]

3

31. 10 years ago, Mr Mehra set up a sinking fund to save for his daughter's higher studies. At the end of 10 years, he has received an amount of ₹ 10,21,760. What amount did he put in the sinking fund at the end of every 6 months for the tenure, which paid him 5% p.a. compounded semi-annually?  
[Use  $(1.025)^{20} = 1.6386$ ]

3

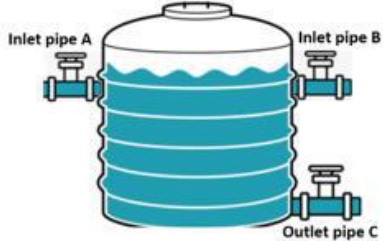
### SECTION – D

(All questions are compulsory. In case of internal choice, attempt any one question only)

|     |   |   |
|-----|---|---|
| 32. | <p>It is known that 3% of plastic buckets manufactured in a factory are defective. Using the Poisson distribution on a sample of 100 buckets, find the probability of:</p> <p>(i) Zero defective buckets<br/>(ii) At most one bucket is defective</p> <p>[Use <math>e^{-3} = 0.049</math>]</p> <p style="text-align: center;"><b>OR</b></p> <p>In a math aptitude test, student scores are found to be normally distributed having mean as 45 and standard deviation 5. What percentage of students have scores -</p> <p>(i) more than the mean score?<br/>(ii) between 30 and 50?</p>  | 5 |
| 33. | <p>An event management company charges ₹ 4,800 per guest, for a bulk booking for 100 guests. In addition, it offers a discount of ₹ 200 for each group of 10 guests over and above 100 guest booking. What is the number of guests that will maximise the amount of money the company receives on a booking? What is the maximum profit on such booking?</p> <p style="text-align: center;"><b>OR</b></p> <p>To manufacture 'x' number of dolls, a company's total cost function <math>C(x)</math> is given by <math>C(x) = 100 + 0.025x^2</math> and the total revenue function <math>R(x)</math> is described as <math>R(x) = 5x</math>. Given that <math>C(x)</math> and <math>R(x)</math> are in thousand rupees, what number of dolls shall be manufactured to maximise the profit of the company? What is the maximum profit?</p> | 5 |
| 34. | <p>Rahul is at the whole sale market to purchase folding tables and chairs, to later sell them at his furniture shop. He has only ₹ 5,760 to spend and his van has space to carry at the most 20 items. A table costs him ₹ 360 and a chair costs ₹ 240. Back at his shop, he plans to sell a table at a profit of ₹ 22 and a chair at a profit of ₹ 18. Given that he can sell all the items that he purchases, how many tables and chairs shall he purchase in order to maximise his profit?</p>  | 5 |
| 35. | <p>The equilibrium conditions for three competitive markets are described as given below, where <math>p_1, p_2</math> and <math>p_3</math> are the equilibrium price for each market respectively.</p> $p_1 + 2p_2 + 3p_3 = 85$ $3p_1 + 2p_2 + 2p_3 = 105$ $2p_1 + 3p_2 + 2p_3 = 110$ <p>Using matrix method, find the values of respective equilibrium prices.</p>   | 5 |

### SECTION – E


(All questions are compulsory. In case of internal choice, attempt any one question only)

|     |   |  |
|-----|---|--|
| 36. | <p><b><u>CASE STUDY – I</u></b></p> <p>An overhead water tank has three pipes A, B and C attached to it (as shown in figure (II)). The inlet pipes A and B can fill the empty tank independently in 15 hours and 12 hours respectively. The outlet pipe C alone can empty a full tank in 20 hours.</p> <p>Based on the above information, answer the following questions. Show steps to support your answers.</p> |  <p style="text-align: center;">FIGURE ( II )</p> |
|-----|---|--|

|    |  |   |
|----|--|---|
| a) | For a routine cleaning of the tank, the tank needs to be emptied. If pipes A and B are closed at the time when the tank is filled to two-fifth of its total capacity, how long will pipe C take to empty the tank completely?  | 1 |
| b) | How long will it take for the empty tank to fill completely, if all the three pipes are opened simultaneously?   | 1 |
| c) | On a given day, pipes A, B and C are opened (in order) at 5 am, 8 am and 9 am respectively, to fill the empty tank. In how many hours will the tank be filled completely?<br><b>OR</b><br>Given that the tank is half-full, only pipe C is opened at 6 AM, to empty the tank. After closing the pipe C and an hour's cleaning time, tank is filled completely by pipe A and B together. What is the total time taken in the whole process? | 2 |


37. **CASE STUDY – II**

When observed over a long period of time, a time series data can predict trend that can forecast increase or decrease or stagnation of a variable under consideration. Such analytical studies can benefit a business for forecasting or prediction of future estimated sales or production. Mathematically, for finding a line of best-fit to represent a trend, many methods are available. Methods like moving-averages and least-squares squares are some of the techniques to predict such trends.



Mrs. Shamita runs a bread factory and the record of her sales of bakery items for the period of 2015 - 2019 is as follows:

| Year                      | 2015 | 2016 | 2017 | 2018 | 2019 |
|---------------------------|------|------|------|------|------|
| Sales<br>(in ₹ thousands) | 35   | 42   | 46   | 41   | 48   |



Based on the above information, answer the following questions. Show steps to support your answers.

|    |   |   |
|----|---|---|
| a) | By taking year 2017 as origin, use method of least-squares to find the best-fit trend line equation for Mrs. Shamita's business. Show the steps of your working.<br><b>OR</b><br>Demonstrate the technique to fit the best-suited straight-line trend by the method of 3-years moving averages. Also draw the trend line. | 2 |
| b) | What are the estimated sales for Mrs. Shamita's business for year 2022?   | 1 |
| c) | Mrs Shamita wishes to grow her business to yearly sale of ₹ 67400. In which year will she be able to reach her target?  | 1 |

38. **CASE STUDY – III**

According to an educational board survey, it was observed that class XII students apply at least one to four weeks ahead of colleges application deadline. Let X represent the week when an average student applies ahead of a college's application deadline and the probability of student to get admission in the college  $P(X = x)$  is given as follows:

$$P(X = x) = \begin{cases} \frac{kx}{6} & \text{when } x = 0, 1 \text{ or } 2 \\ \frac{(1-k)x}{6} & \text{when } x = 3 \\ \frac{kx}{2} & \text{when } x = 4 \\ 0 & \text{when } x > 4 \end{cases}$$

Where  $k$  is a real number.

Based on the above information, answer the following questions. Show steps to support your answers.

|    |   |   |
|----|---|---|
| a) | Find the value of $k$ .   | 1 |
| b) | What is the probability that Sonali will get admission in the college, given that she applied at least 2 weeks ahead of application deadline?   | 1 |
| c) | <p>Calculate the mathematical expectation of number of weeks taken by a student to apply ahead of a college's application deadline.</p> <p style="text-align: center;"><b>OR</b></p> <p>To promote early admissions, the college is offering scholarships to the students for applying ahead of deadline as follows:</p> <p style="text-align: center;">₹ 50000 for applying 4 weeks early,<br/> ₹ 20000 for applying 3 weeks early,<br/> ₹ 12000 for applying 2 weeks early,<br/> and ₹ 9600 for applying 1 week early</p> <p>What is the expected scholarship offered by the college?</p> | 2 |

-----